

Innovations in Earthquake Monitoring, Risk Assessment, and Preparation

David Applegate

U.S. Geological Survey

April 22, 2011

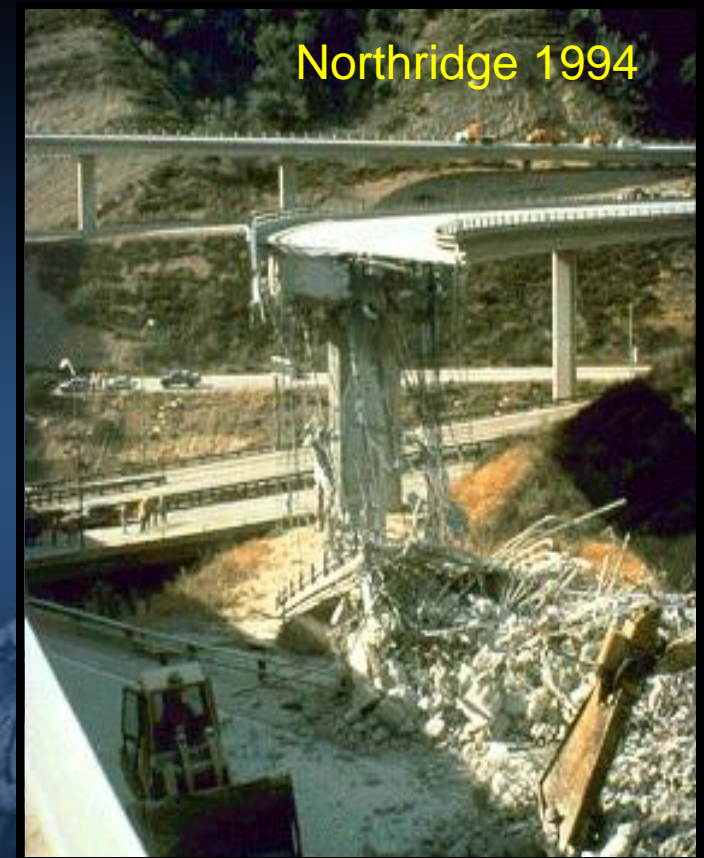
Statutory Roles and Responsibilities

- USGS has the delegated federal responsibility to provide notifications and warnings for **earthquakes**, **volcanic eruptions**, and **landslides**.
- USGS seismic networks support NOAA's **tsunami** warnings.
- USGS streamgages and storm surge monitors support NOAA's **flood** and **severe weather (including hurricane)** warnings.
- USGS geomagnetic observatories support NOAA and AFWA **geomagnetic storm** forecasts.
- USGS geospatial information supports response operations for **wildfire** and many other disasters.



The mandate of the National Earthquake Hazard Reduction Program

- Develop effective measures for earthquake loss reduction;
- Promote their adoption;
- Improve the understanding of earthquakes and their effects on communities, buildings, structures, and lifelines.



FEMA

NIST

National Institute of
Standards and Technology

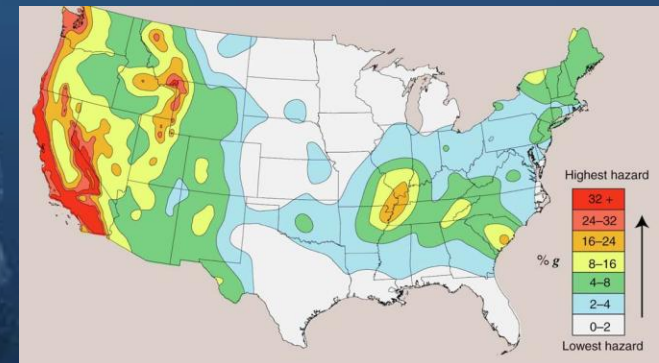


USGS
science for a changing world

national **earthquake** hazards reduction program

The USGS role in the National Earthquake Hazard Reduction Program partnership

- Provide earthquake monitoring and notifications,
- Assess seismic hazards,
- Conduct targeted research needed to reduce the risk from earthquake hazards nationwide, and
- Work with NEHRP agencies and many other partners to support public awareness of earthquake hazards and impacts.



FEMA

NIST

National Institute of
Standards and Technology

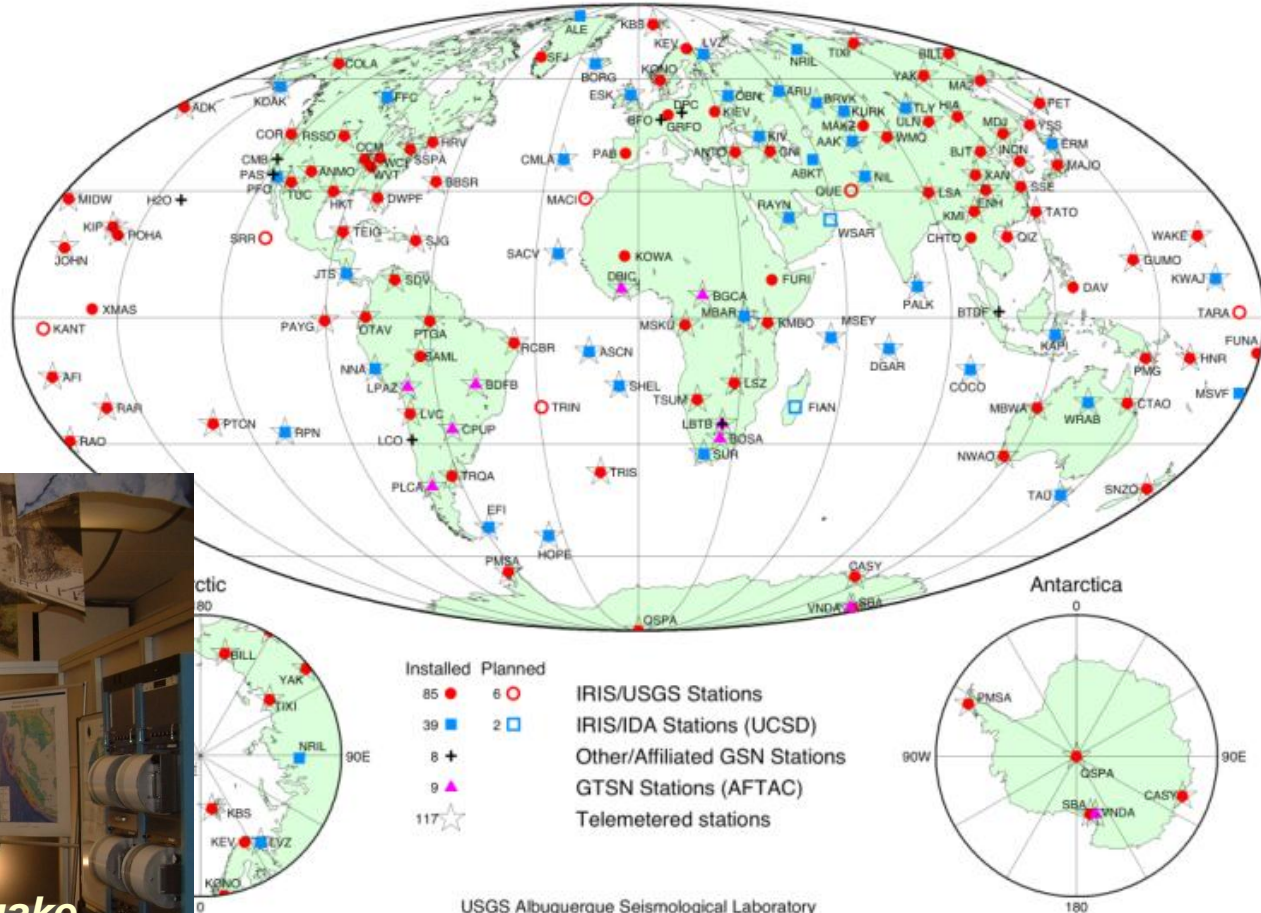


USGS
science for a changing world

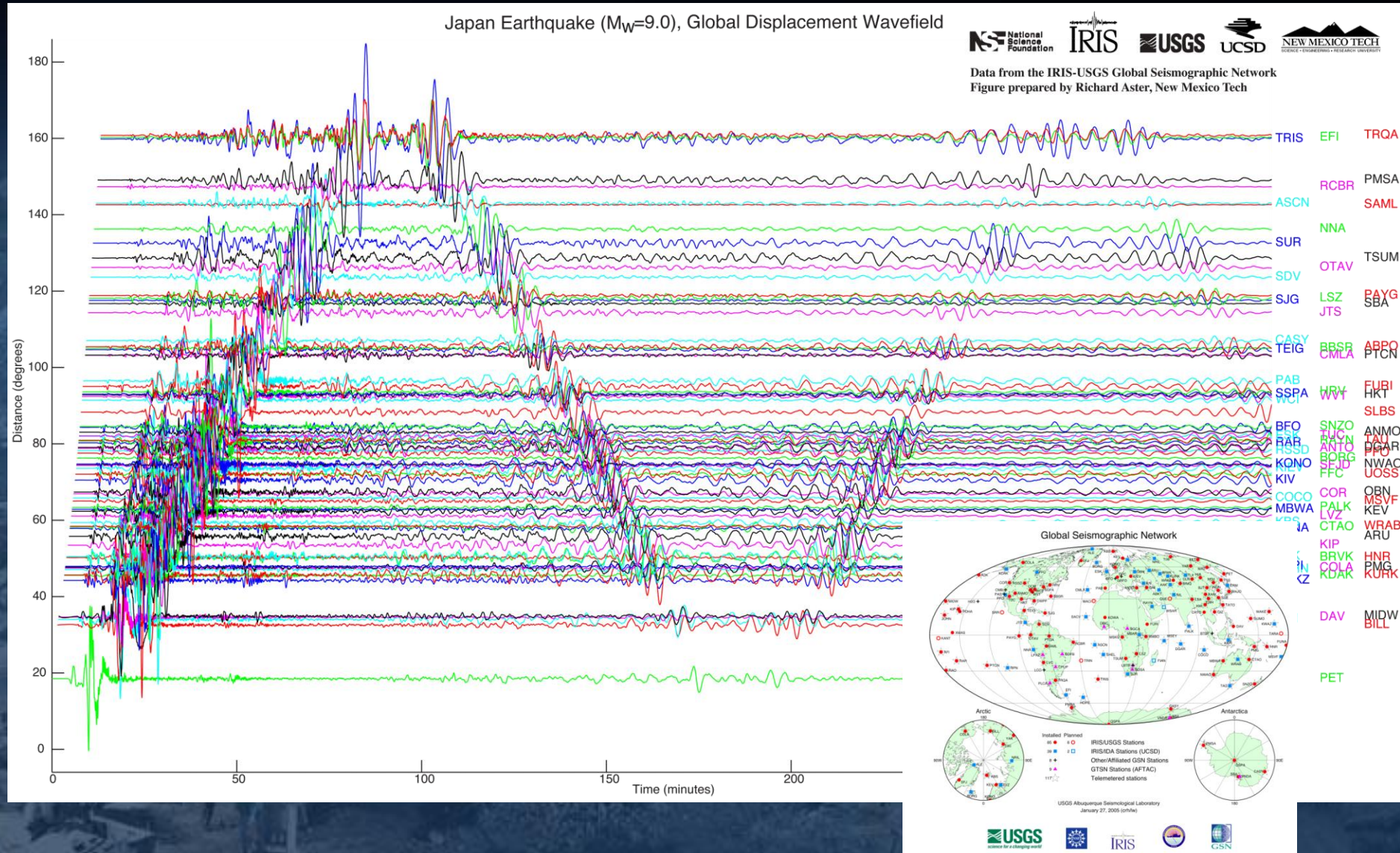
national **earthquake** hazards reduction program

USGS provides rapid information on earthquakes worldwide

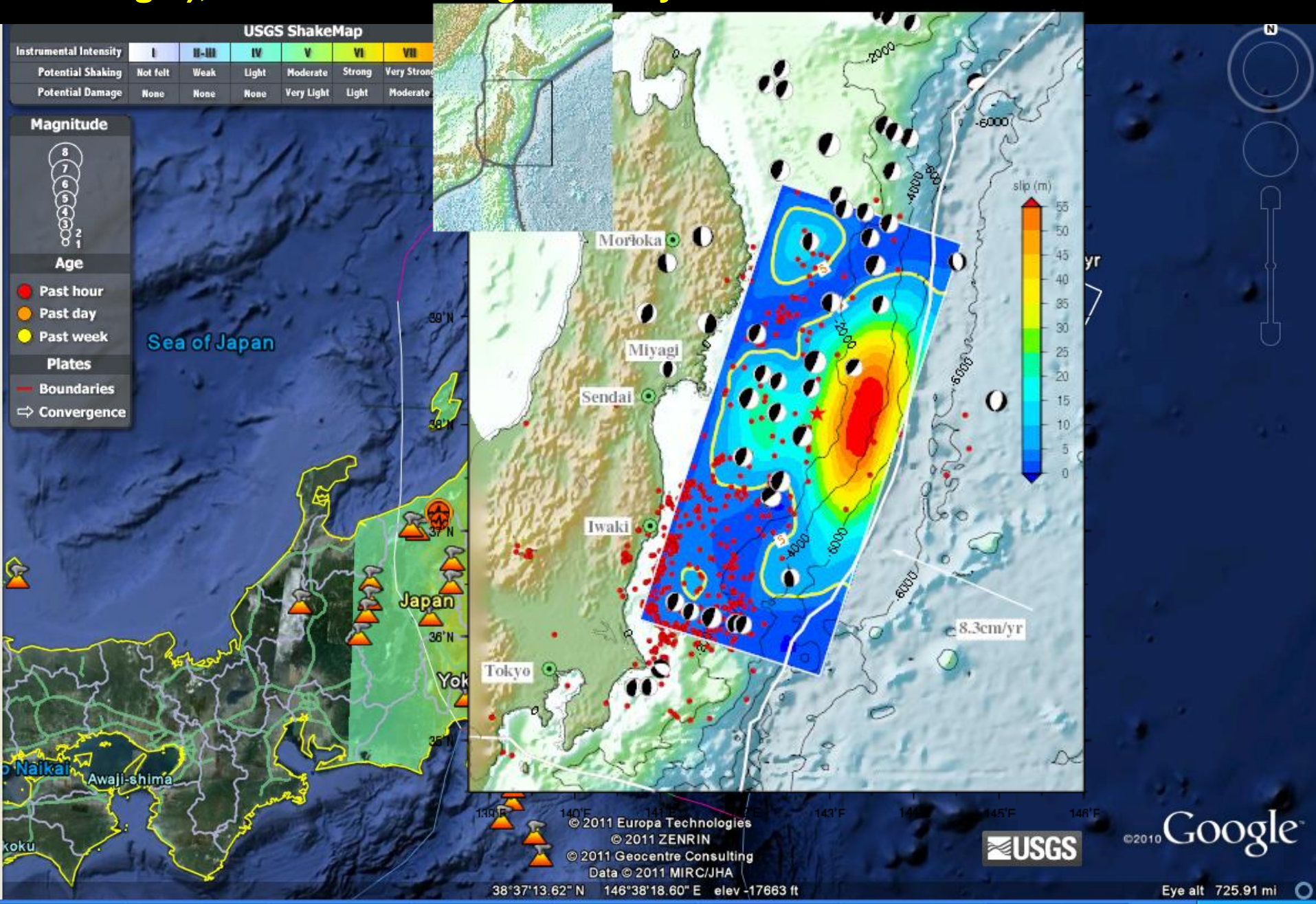
Global Seismographic Network



Giant earthquakes ring the Earth like a bell

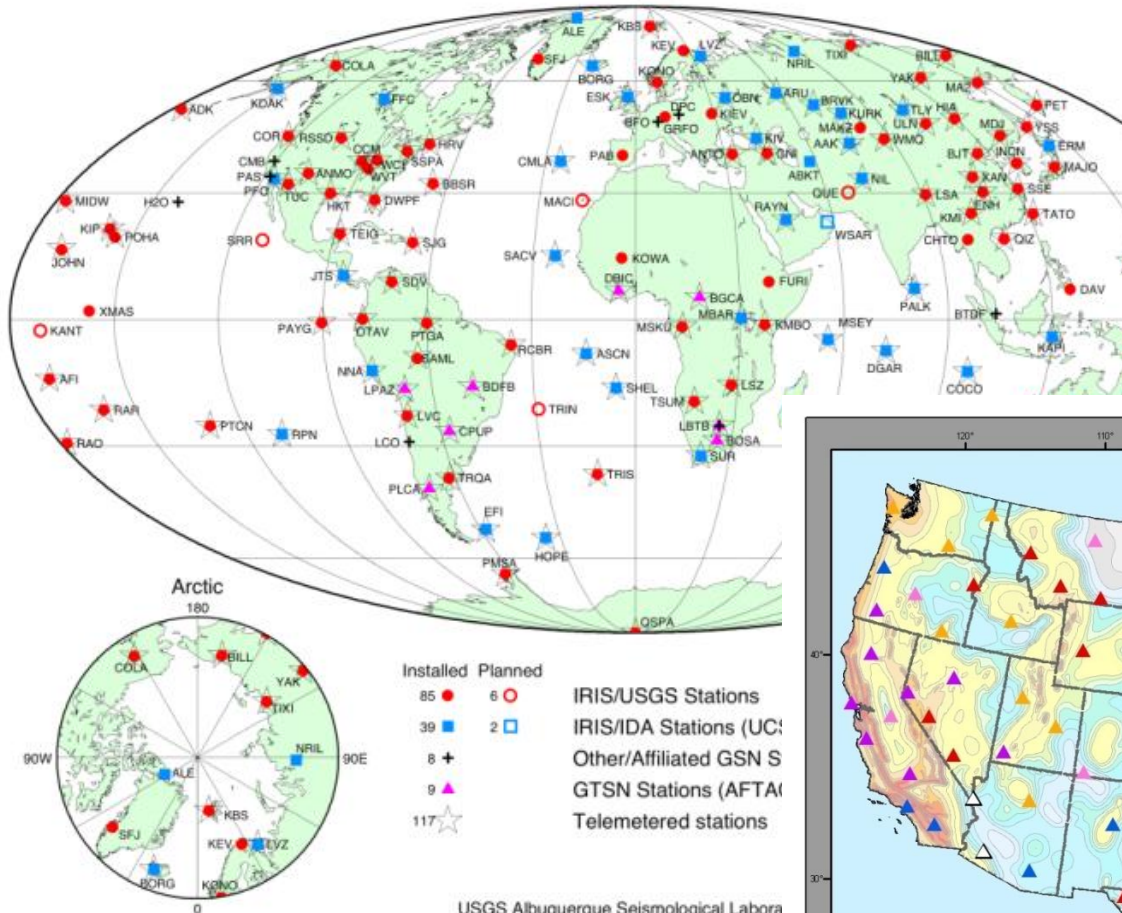


GoogleEarth feed from USGS showing fault rupture plane (blue rectangle), modeled shaking intensity and aftershocks



USGS provides rapid information on earthquakes worldwide

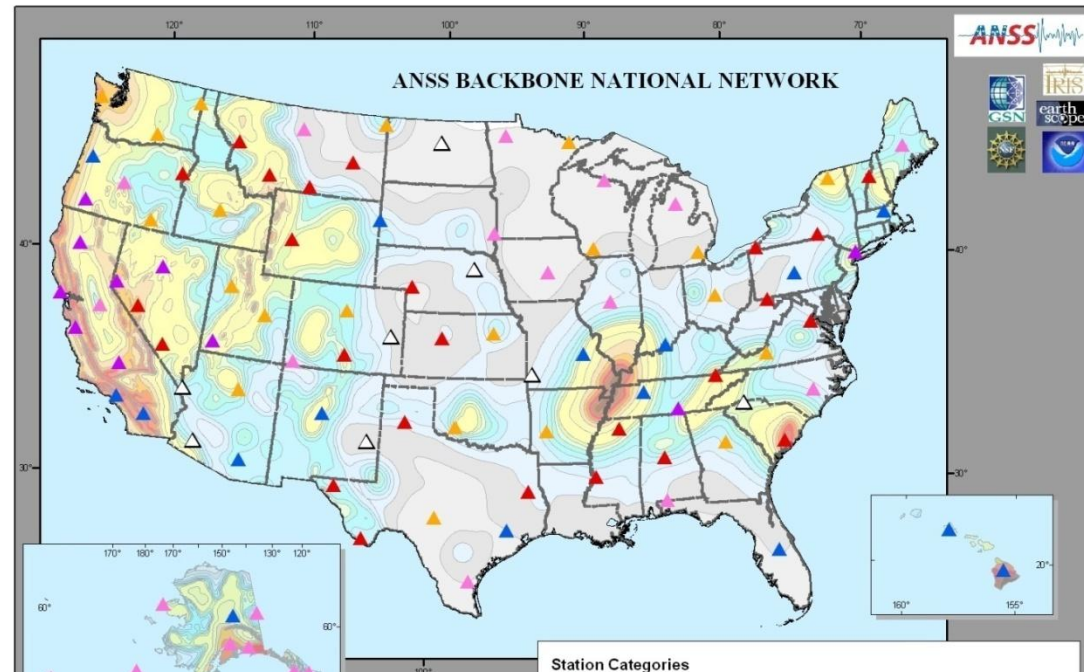
Global Seismographic Network



USGS Albuquerque Seismological Laboratory
January 27, 2005 (crh/lw)

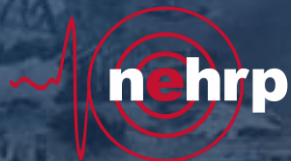


USGS National Earthquake
Information Center,
Golden, Colorado



USGS Earthquake Notification System

Over
200,000
users



USGS Earthquake Hazards Program » Earthquake Notification Service: Customizable Alerts

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Latest Earthquakes

- USA
- World

EQ Notification Service

- Feeds & Data
- Animations
- Recent Earthquakes
- Historic Earthquakes
- "Top 10" Lists & Maps
- Significant EQs
- Earthquake Search
- EQ Summary Posters
- Scientific Data
- About EQ Maps
- Did You Feel It?
- Energy & Broadband Solutions
- Fast Moment Tensors
- Media Info
- PAGER
- Seismogram Displays
- ShakeMaps

This system provides automated email notification for worldwide earthquakes. It's a free service offered by the U.S. Geological Survey.

Introduction to ENS - What you need to know

Manage Your Account

Username:

Password:

OR

Register for a New Account

[See recent events processed](#)

[Forgot your username or password?](#)

If you have questions or problems, [Send mail to the ENS Administrator.](#)


http://earthquake.usgs.gov/ens/

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[U.S. Department of the Interior](#) | [U.S. Geological Survey](#)
URL: <http://earthquake.usgs.gov/eqcenter/ens/index.php>
Page Contact Information: [Web Team](#)

[FIRSTGOV.gov](#)
The U.S. Government's Official Web Portal

 **TAKE PRIDE**

ENS can be customized to suit your needs

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Learning & Education Research & Monitoring Additional Resources
Service » Earthquake Notification Service: Customizable Earthquake Alerts

Notification Service: Customizable Earthquake

Welcome waldjd!
Log Out
Recent Events Sent to Me
Map of Recent Events
My Email Addresses
3036386000@mmode.com (short)
3036386000@vtext.com (short)
wald@usgs.gov (long)
Add New Email Address
Add New Profile
☐ Predefined Profile
☒ Rectangle Profile
☐ Circle Profile
☐ Polygon Profile

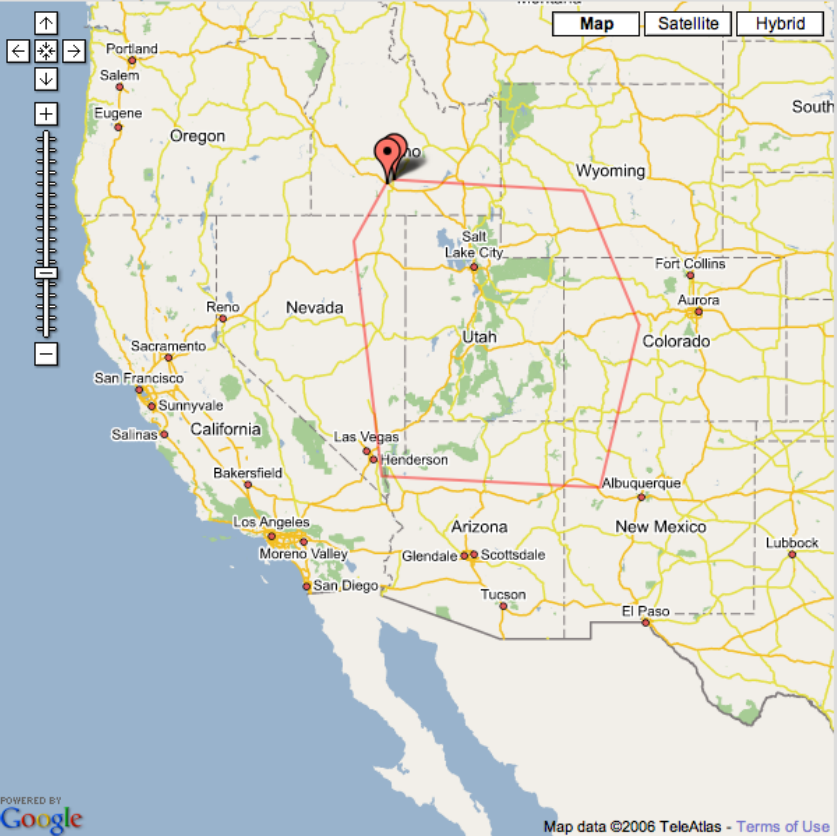
Admin Functions
Recent Events List
Recent Events Map
Admin Page

http://earthquake.usgs.gov - Mozilla Firefox
Click on the map to define your polygon boundary. You may have up to 50 points in your polygon. Click 'Done' when finished.

Back up one point Number of points: 7
Done

USGS ENS Map Input

Map Satellite Hybrid



Map data ©2006 TeleAtlas - Terms of Use

Depth: 0.00 to 800.00km
Networks: CI,NC,NN,UU,UW,AK,NM,HV,AT,PR,SE,US,LD,MB,WY,AR
Geographic Bounds: polygon

Day Mag: 4
Night Mag: 4.5
Day Begins: 08:00
Day Ends: 22:00
Address 1: 3036386000@vtext.com (short)
Address 2: wald@usgs.gov (long)
DELETE PROFILE EDIT PROFILE

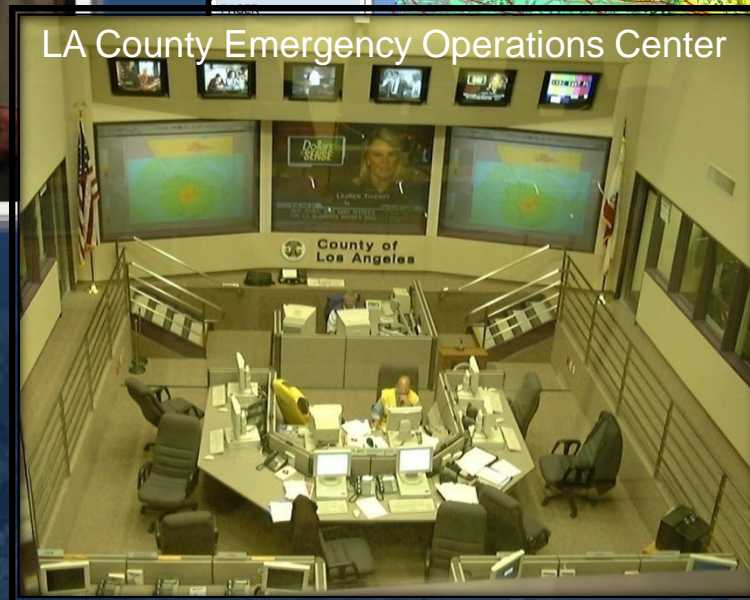
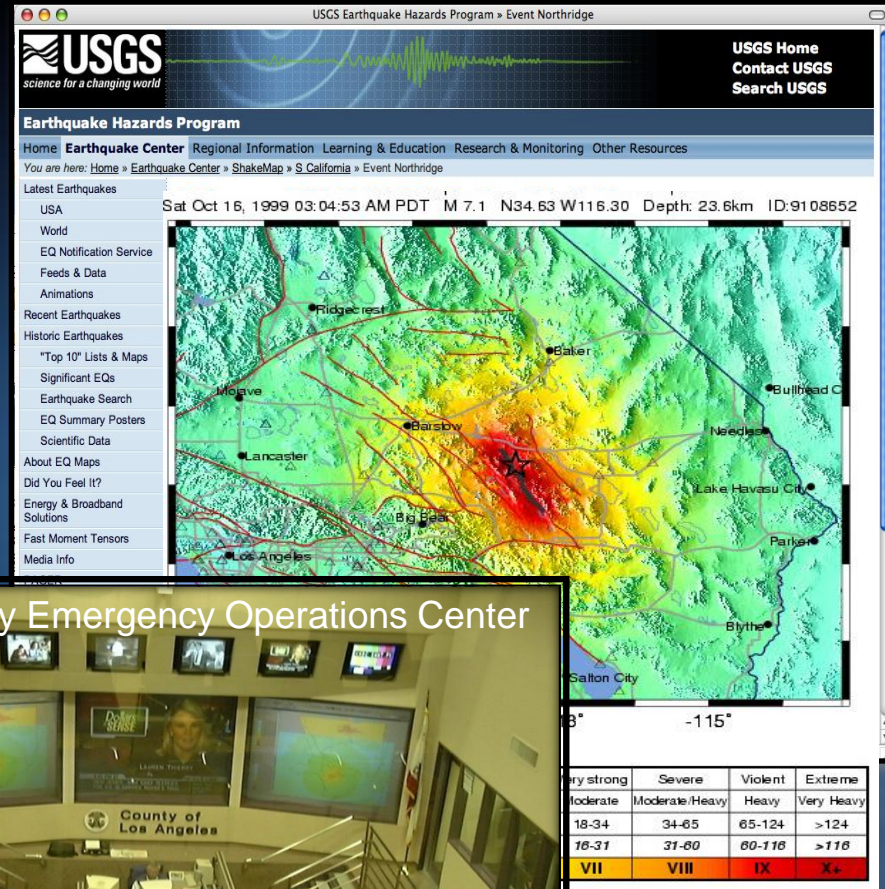
Depth: 0.00 to 800.00km
Networks: CI,NC,NN,UU,UW,AK,NM,HV,AT,PR,SE,US,LD,MB,WY,AR
Geographic Bounds: rectangle

South Latitude:	-90.000
North Latitude:	90.000
East Longitude:	180.000
West Longitude:	-180.000
Day Mag:	5.7
Night Mag:	6.1

ShakeMap: A tool for rapid post-earthquake response, coordination, and situational awareness



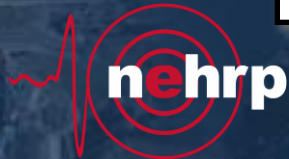
California Governor Schwarzenegger pointing to ShakeMap at his press conference following the 2008 M5.4 Chino Hills earthquake that hit LA.



ShakeCast



Automated
notifications to
operators of
critical facilities



Caltans ShakeCast System

All VA_HOSP



Facility Damage Estimates from ShakeMap

Bridges presented in the table below are sorted in order of potential damage level.

Bridge Name	Bridge No	Dist-Cty-Rte-PM	Damage Level	Value	Exceedance Ratio
Pisgah Overhead	54 0689L	08-SBD-040-R37.41	RED	47.6856	1.163
Pisgah Overhead	54 0689R	08-SBD-040-R37.44	RED	47.6856	1.163
Lavic Road OC	54 0734	08-SBD-040-R41.91	YELLOW	56.4714	0.867
Ash Hill Wash	54 0758L	08-SBD-040-R54.75	GREEN	25.5495	0.887
Ash Hill Wash	54 0758R	08-SBD-040-R54.77	GREEN	25.5495	0.887
Argos Wash	54 0737L	08-SBD-040-R43.84	GREEN	48.8524	0.053
Argos Wash	54 0737R	08-SBD-040-R43.84	GREEN	48.8524	0.053



USGS ShakeMap : OFFSHORE MAULE, CHILE

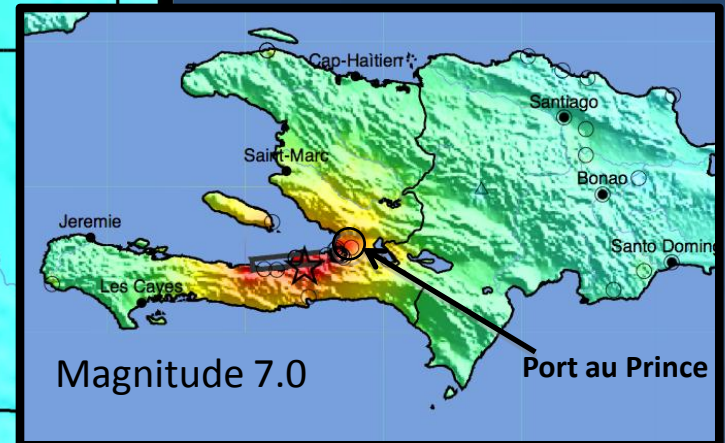
Sat Feb 27, 2010 06:34:14 GMT M 8.8 S35.85 W72.72 Depth: 35.0km ID:2010tfan

Magnitude 8.8

**USGS ShakeMap
Estimated Shaking
Intensities**

Same Map Scale!

Haiti, Jan 10, 2010



PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	<.17	.17-1.4	1.4-3.9	3.9-9.2	9.2-18	18-34	34-65	65-124	>124
PEAK VEL.(cm/s)	<0.1	0.1-1.1	1.1-3.4	3.4-8.1	8.1-16	16-31	31-60	60-116	>116
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

Situational awareness available in 20 minutes

Prompt Assessment of Global Earthquakes for Response

Rapidly estimated that over 2 million people were exposed to violent shaking



M 7.0, HAITI REGION

Origin Time: Tue 2010-01-12 21:53:10 UTC

Location: 18.46°N 72.53°W Depth: 13 km



USAID
FROM THE AMERICAN PEOPLE

PAGER
Version 8

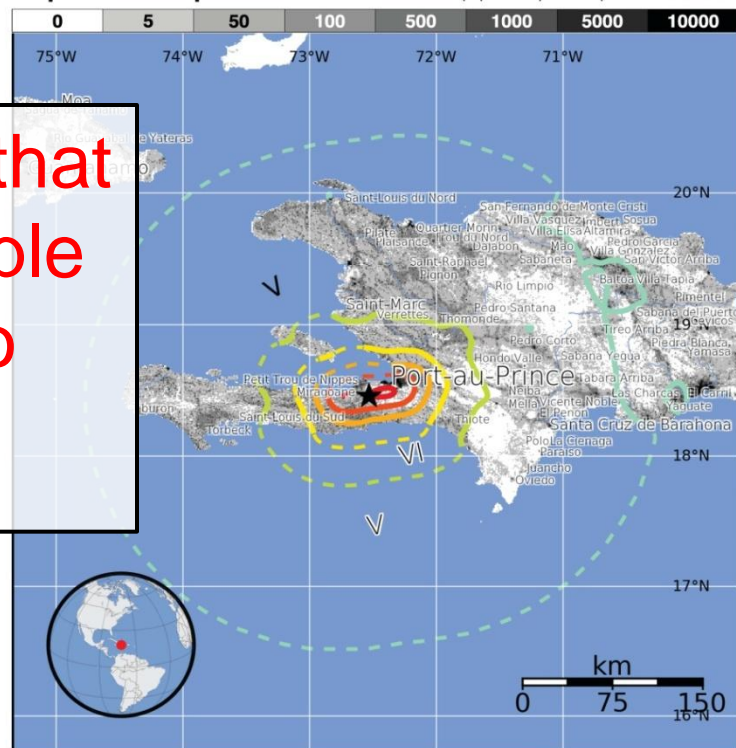
Created: 1 day, 20 hours after earthquake

Estimated Population Exposed to Earthquake Shaking

ESTIMATED POPULATION EXPOSURE (k = x1000)	--*	--*	5,887k*	7,261k	1,049k	571k	314k	2,246k	332k
ESTIMATED MODIFIED MERCALLI INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+
PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very Strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	Resistant Structures	none	none	none	V. Light	Light	Moderate	Moderate/Heavy	V. Heavy
	Vulnerable Structures	none	none	none	Light	Moderate	Moderate/Heavy	Heavy	V. Heavy

*Estimated exposure only includes population within the map area.

Population Exposure



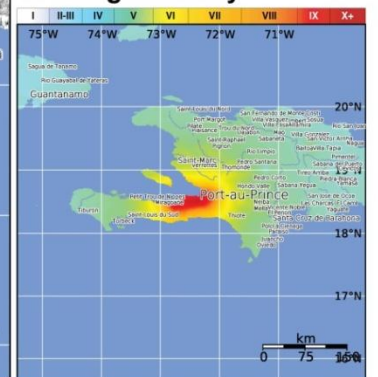
Selected City Exposure

MMI City	Population
X Grand Goave	5k
IX Port-au-Prince	1,235k
IX Carrefour	442k
IX Petionville	108k
IX Delmas 73	383k
IX Croix des Bouquets	9k
VI Miragoane	6k
V Verrettes	49k
III Santo Domingo	2,202k
III Guantanamo	273k

bold cities appear on map

(k = x1000)

Shaking Intensity



SAMPLE PAGER ALERT RECIPIENTS

The World Bank

IBRD & IDA: Working for a World F



China's earthquake emergency rescue center



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MercyCorps

Be the change



Australian Government

Geoscience Australia

AP **Associated Press**

GEOHAZARDS INTERNATIONAL
A Nonprofit Working Toward Global Earthquake Safety

UPI.com
100 YEARS OF JOURNALISTIC EXCELLENCE



**Earthquake Engineering
Research Institute**

GDACS

**Global Disaster Alert &
Coordination System**



REUTERS

Aid Agencies/NGO

International



THE WHITE HOUSE

PRESIDENT GEORGE W. BUSH

ANSS

Federal Government



FEMA



U.S. DEPARTMENT of STATE



**Homeland
Security**



USNORTHCOM
DEFENDING OUR HOMELAND



Office of Science and Technology Policy



M 8.8, OFFSHORE MAULE, CHILE

Origin Time: Sat 2010-02-27 06:34:14 UTC (02:34:14 local)

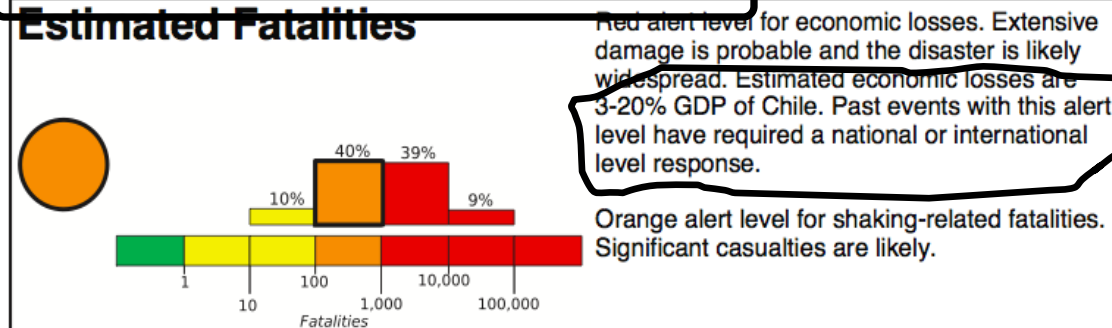
Location: 35.85°S 72.72°W Depth: 35 km

FOR TSUNAMI INFORMATION, SEE: tsunami.noaa.gov

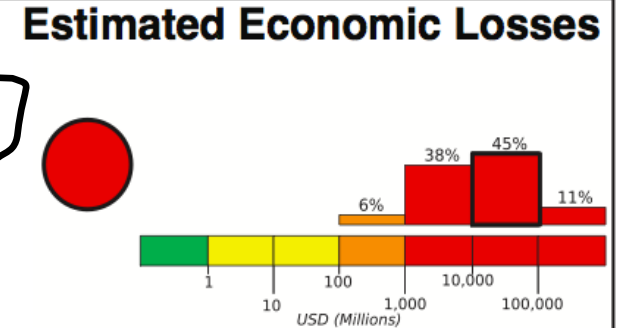
**PAGER
Version 3**

Created: 3 hours, 10 minutes after earthquake

Estimated Fatalities



Estimated Economic Losses



Estimated Population Exposed to Earthquake Shaking

ESTIMATED POPULATION EXPOSURE (k = x1000)	--*	--*	487k*	2,147k*	3,657k	6,405k	3,083k	0	0
ESTIMATED MODIFIED MERCALLI INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+
PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very Strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	Resistant Structures	none	none	none	V. Light	Light	Moderate	Moderate/Heavy	Heavy
	Vulnerable Structures	none	none	none	Light	Moderate	Moderate/Heavy	Heavy	V. Heavy

*Estimated exposure only includes population within the map area.



PAGER content is automatically generated, and does not consider secondary hazards in loss calculations. Limitations of input data, shaking estimates, and loss models may add uncertainty.
<http://earthquake.usgs.gov/pager>

VIII Arauco	25k
VIII Lota	50k
VIII Concepcion	215k
VIII Constitucion	38k
VII Bulnes	13k
VII Cabrero	18k
VI Temuco	238k
VI Valparaiso	282k
VI Santiago	4,837k
IV Mendoza	877k
III Neuquen	242k

bold cities appear on map

(k = x1000)

Event ID: us2010tfan



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M 7.0, HAITI REGION

Origin Time: Tue 2010-01-12 21:53:10 UTC (16:53:10 local)
Location: 18.45°N 72.57°W Depth: 13 km

Summary Alert ● Red

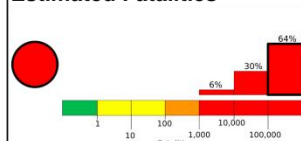


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PAGER
Version 1

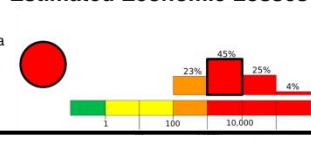
Created: 1 month, 2 weeks after earthquake

Estimated Fatalities



Red alert for fatalities and economic losses. High casualties and widespread damage are likely and the disaster is potentially widespread. Past red alerts have required a national or international response.

Estimated Economic Losses



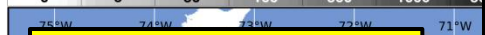
Estimated Population Exposed to Earthquake

ESTIMATED POPULATION EXPOSURE (k = x1000)	--*	50k*	7,272k*	6,149k
ESTIMATED MODIFIED MERCALLI INTENSITY	I	II-III	IV	V
PERCEIVED SHAKING	Not felt	Weak	Light	Moderate
POTENTIAL DAMAGE	Resistant Structures: none Vulnerable Structures: none	none	none	V. Light

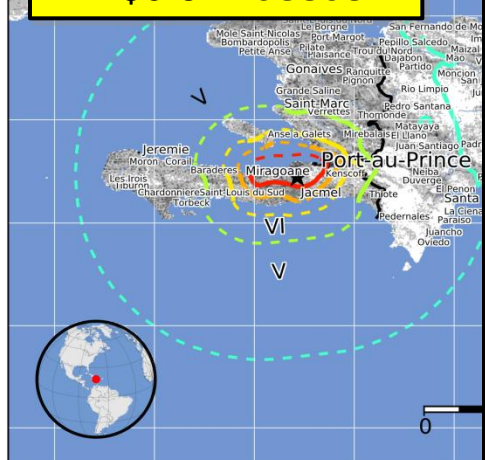
*Estimated exposure only includes population within the map area.

Population Exposure

population per ~1 sq. km



**230,000 fatalities;
~\$6-9B losses**



This information was automatically generated.
<http://earthquake.usgs.gov/pager>



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M 7.0, SOUTH ISLAND OF NEW ZEALAND

Origin Time: Fri 2010-09-03 16:35:46 UTC (04:35:46 local)
Location: 43.53°S 172.12°E Depth: 5 km

Summary Alert ● Red

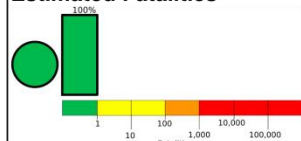


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PAGER
Version 5

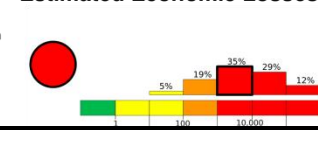
Created: 7 hours, 10 minutes after earthquake

Estimated Fatalities



Red alert level for economic losses. Extensive damage is likely and the disaster is potentially widespread. Estimated economic losses are 1-10% GDP of New Zealand. Past events with this alert level have required a national or international level response.

Estimated Economic Losses



Green alert level for fatalities. There is a low likelihood of casualties.

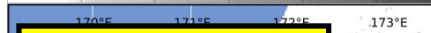
Estimated Population Exposed to Earthquake

ESTIMATED POPULATION EXPOSURE (k = x1000)	--*	147*	91k*	111
ESTIMATED MODIFIED MERCALLI INTENSITY	I	II-III	IV	V
PERCEIVED SHAKING	Not felt	Weak	Light	Moderate
POTENTIAL DAMAGE	Resistant Structures: none Vulnerable Structures: none	none	none	V. Light

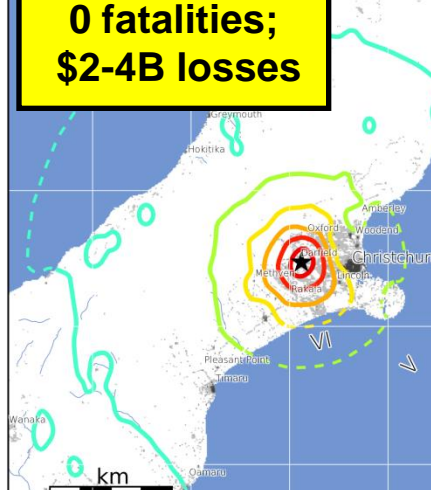
*Estimated exposure only includes population within the map area.

Population Exposure

population per ~1 sq. km



**0 fatalities;
\$2-4B losses**



science for a changing world

M 8.8, OFFSHORE MAULE, CHILE

Origin Time: Sat 2010-02-27 06:34:14 UTC (02:34:14 local)
Location: 35.85°S 72.72°W Depth: 35 km

FOR TSUNAMI INFORMATION, SEE: tsunami.noaa.gov

Earthquake Shaking ● Red Alert

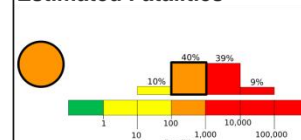


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PAGER
Version 3

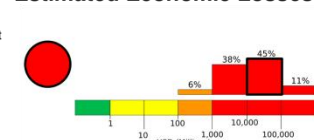
Created: 3 hours, 10 minutes after earthquake

Estimated Fatalities



Red alert level for economic losses. Extensive damage is probable and the disaster is likely widespread. Estimated economic losses are 3-20% GDP of Chile. Past events with this alert level have required a national or international level response.

Estimated Economic Losses



Orange alert level for shaking-related fatalities. Significant casualties are likely.

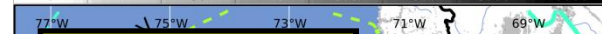
Estimated Population Exposed to Earthquake Shaking

ESTIMATED POPULATION EXPOSURE (k = x1000)	--*	--*	487k*	2,147k*	3,657k	6,405k	3,083k	0	0
ESTIMATED MODIFIED MERCALLI INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+
PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very Strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	Resistant Structures: none Vulnerable Structures: none	none	none	V. Light	Light	Moderate	Moderate/Heavy	Heavy	V. Heavy

*Estimated exposure only includes population within the map area.

Population Exposure

population per ~1 sq. km from Landsat



**490 fatalities;
~\$15-30B losses**

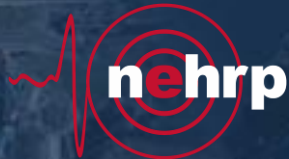


Structures:
Overall, the population in this region resides in structures that are resistant to earthquake shaking, though some vulnerable structures exist. The predominant vulnerable building types are low-rise reinforced/concrete masonry and adobe block construction.

Historical Earthquakes (with MMI levels):

Date	Dist. (km)	Mag.	Max MMI(#)	Shaking Deaths
1985-03-03	308	7.9	VIII(301k)	
1985-03-03	352	7.0	IX(174k)	
1985-03-03	313	7.9	VIII(5 433k)	

Red Alert PAGER for the Tohoku earthquake issued in 42 minutes



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Earthquake Shaking **Red Alert**

M 8.9, NEAR THE EAST COAST OF HONSHU, JAPAN

Origin Time: Fri 2011-03-11 05:46:23 UTC (14:46:23 local)

Location: 38.32°N 142.37°E Depth: 24 km

FOR TSUNAMI INFORMATION, SEE: tsunami.noaa.gov

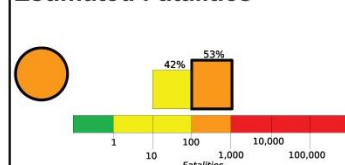


ANSS

**PAGER
Version 4**

Created: 2 hours, 6 minutes after earthquake

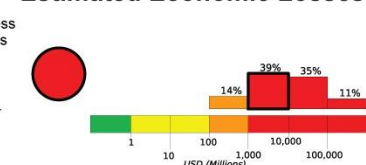
Estimated Fatalities



Red alert level for economic losses. Extensive damage is probable and the disaster is likely widespread. Estimated economic losses are less than 1% of GDP of Japan. Past events with this alert level have required a national or international level response.

Orange alert level for shaking-related fatalities. Significant casualties are likely.

Estimated Economic Losses

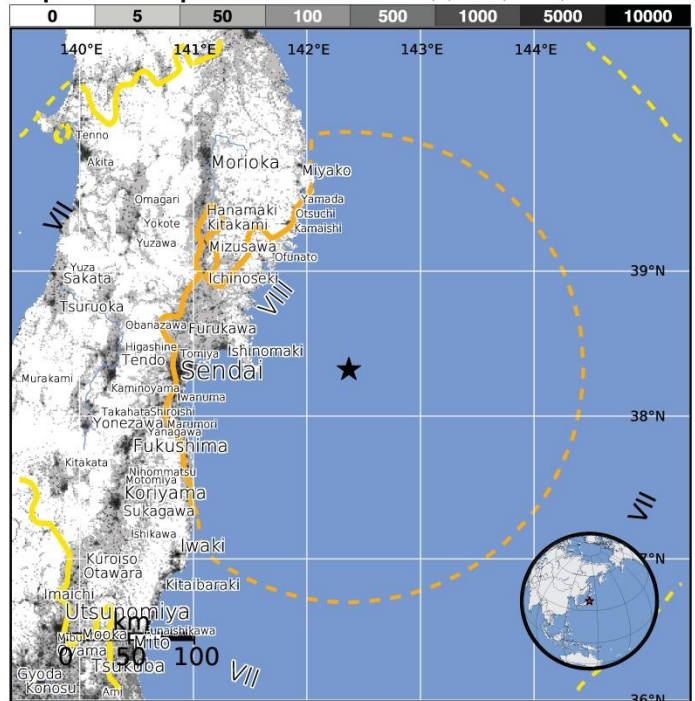


Estimated Population Exposed to Earthquake Shaking

ESTIMATED POPULATION EXPOSURE (k = x1000)	--*	--*	--*	--*	2,472k*	7,986k*	2,598k	0	0
ESTIMATED MODIFIED MERCALLI INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+
PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very Strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	Resistant Structures	none	none	none	V. Light	Light	Moderate	Moderate/Heavy	Heavy
	Vulnerable Structures	none	none	none	Light	Moderate	Moderate/Heavy	Heavy	V. Heavy

*Estimated exposure only includes population within the map area.

Population Exposure



Structures:

Overall, the population in this region resides in structures that are resistant to earthquake shaking, though some vulnerable structures exist. The predominant vulnerable building types are non-ductile reinforced concrete frame and heavy wood frame construction.

Historical Earthquakes (with MMI levels):

Date (UTC)	Dist. (km)	Mag.	Max MMI(#)	Shaking Deaths
1998-06-14	363	5.7	VII(428k)	0
1994-12-28	263	7.7	VII(132k)	3
1983-05-26	369	7.7	VII(174k)	104

Recent earthquakes in this area have caused secondary hazards such as tsunamis, landslides, and fires that might have contributed to losses.

Selected City Exposure

from GeoNames.org

MMI City	Population
VIII Ishinomaki	117k
VIII Shiogama	60k
VIII Yamato	32k
VIII Kogota	20k
VIII Rifu	35k
VIII Furukawa	76k
VIII Yamagata	255k
VII Morioka	295k
VII Sendai	1,038k
VII Fukushima	294k
VII Utsunomiya	450k

bold cities appear on map

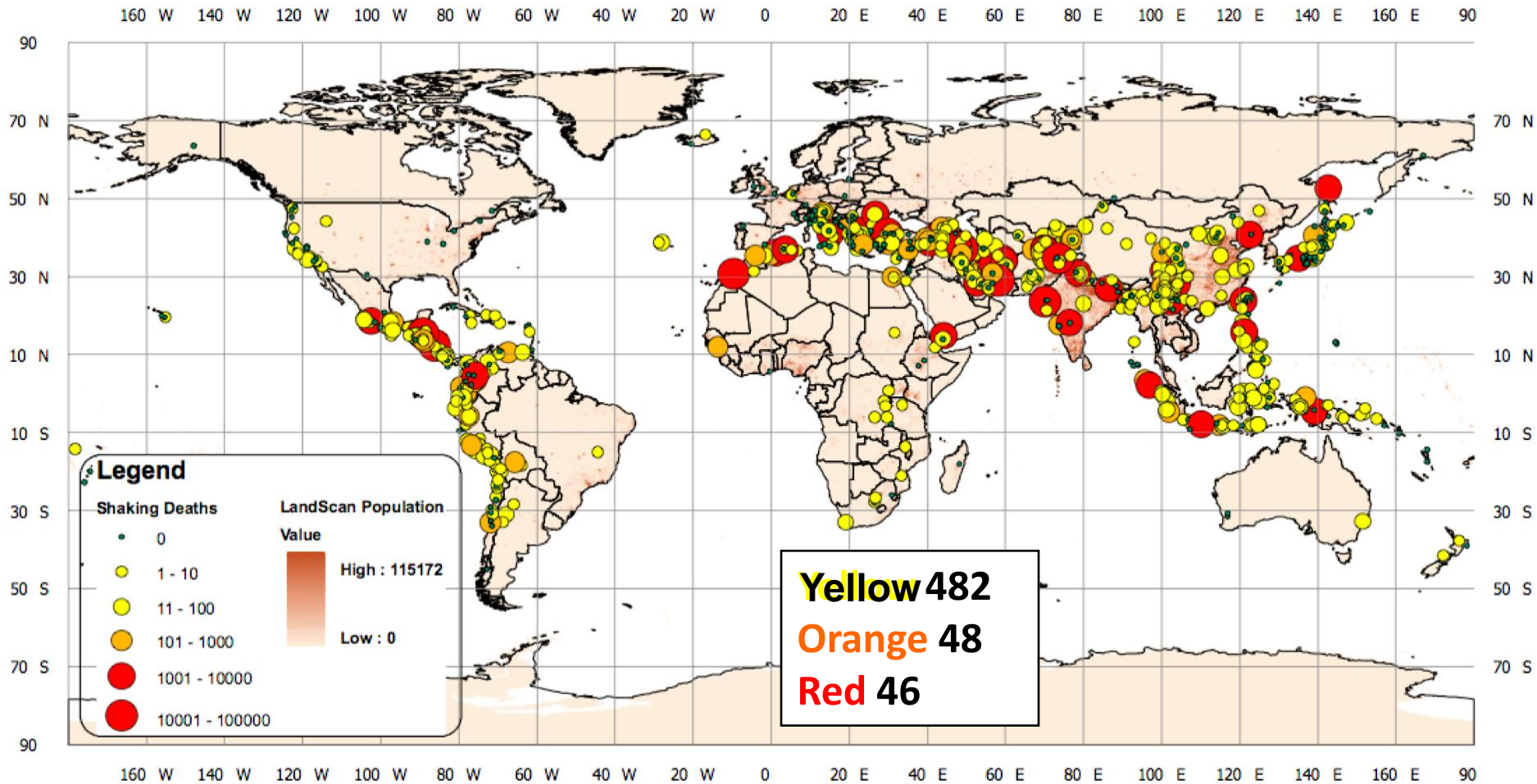
(k = x1000)

PAGER content is automatically generated, and only considers losses due to structural damage. Limitations of input data, shaking estimates, and loss models may add uncertainty.

<http://earthquake.usgs.gov/pager>

Event ID: usc0001xgp

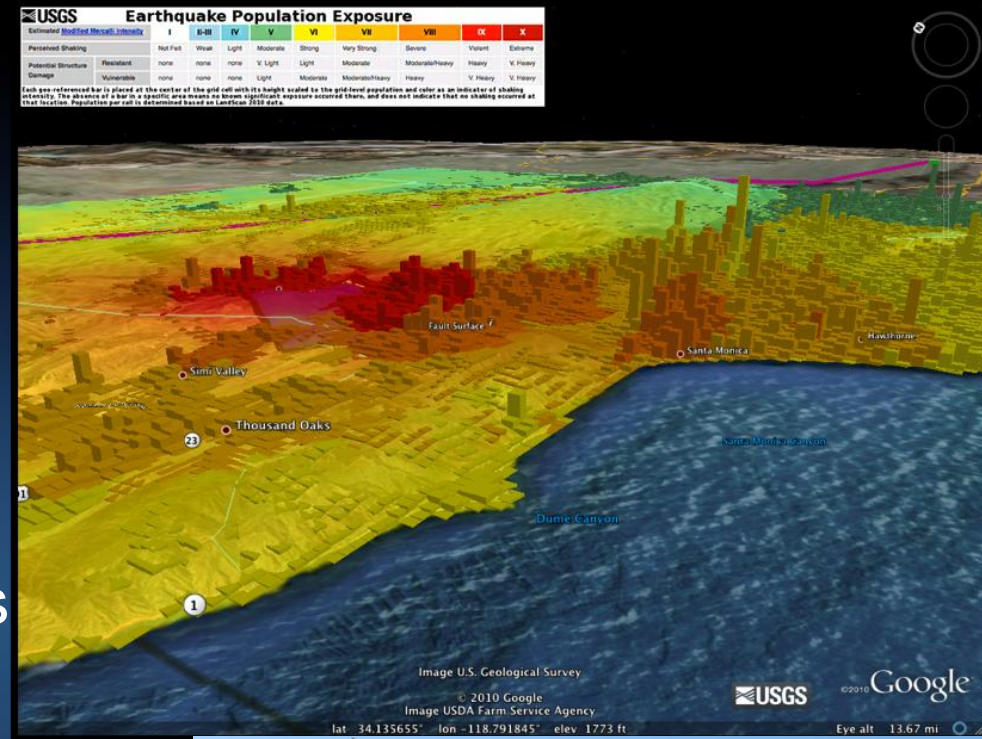
Global Fatality-based alerts over the past 40 years



Map of fatality-based alert levels that would be triggered given the observed fatalities for events over the past forty years. The legend provides the fatality threshold for color-coded alert level. There would have been about 5,000 green, 490 yellow, 51 orange, and 48 red alerts (approximately 12 yellow, 1-2 orange, and 1-2 red alerts per year).

Future development of PAGER tools

- Develop strategies for estimating non-fatal casualties and displaced persons
- Generate loss estimates for scenario events
- Develop advanced 3-D zoomable visualization tools for PAGER impact information.
- Develop a global, country-specific building vulnerability index.

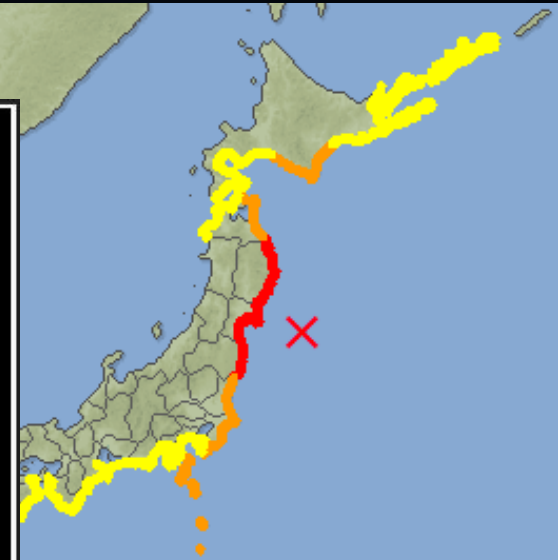


Japanese early warning systems

Issued at 14:49 JST, 11 March 2011



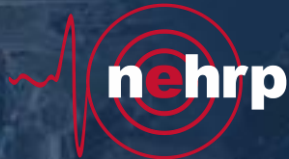
Automatic earthquake warning triggered by computer



Japan
Meteorological
Agency initial
tsunami warning

All rights reserved. Copyright © Japan Meteorological Agency

USGS



Notes

Tsunami Warning

Major Tsunami

Tsunami height is estimated to be 3 meters or more

Tsunami

Tsunami height is estimated to be up to 2 meters

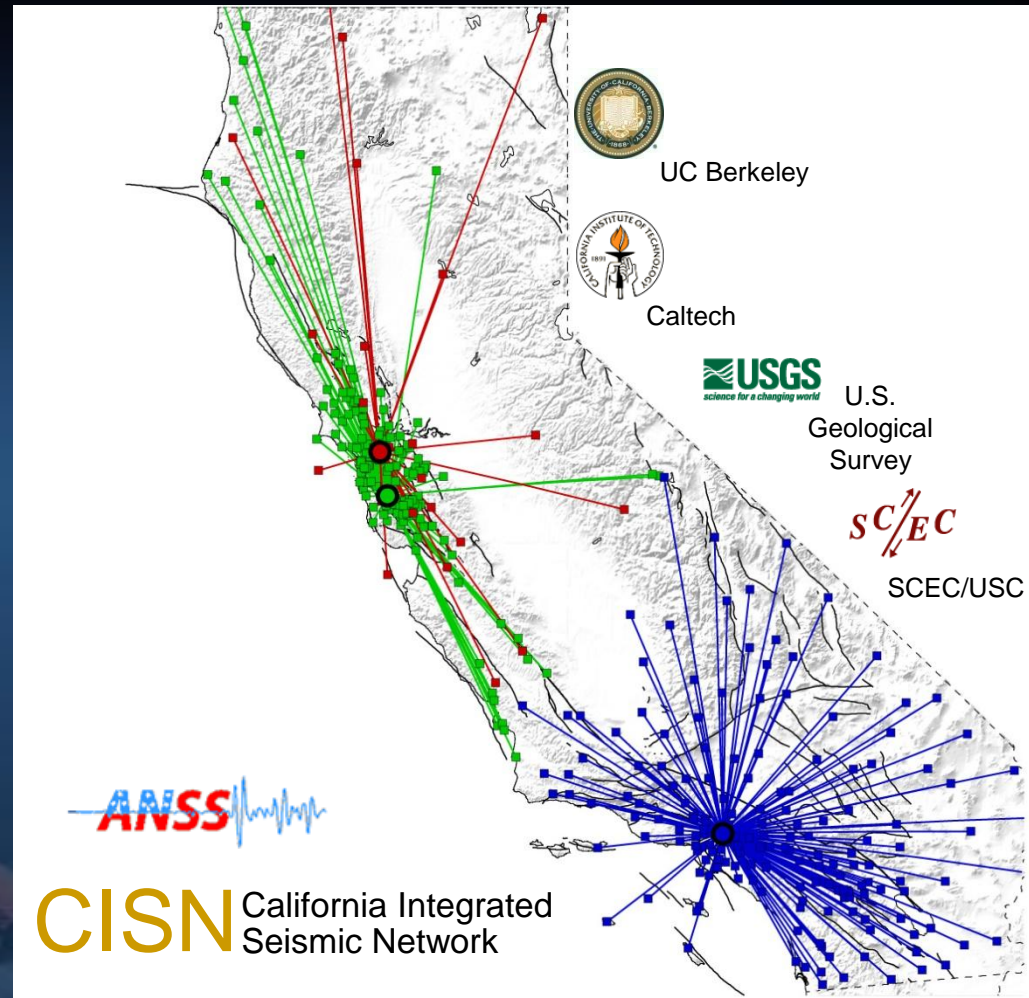
Tsunami Advisory

Tsunami height is estimated to be about 0.5 meter

× Epicenter

Earthquake early warning – getting ahead of strong ground shaking

- USGS/CISN Phase I (2007-2009) cooperative agreement supported algorithm testing
- Phase II (2010-2012) supports prototype development and identifies test users
- ARRA funding used to reduce datalogger delays
- EEW requirements:
 - rapid earthquake detection
 - early magnitude estimation
 - ground shaking prediction
 - robust monitoring networks
 - well-defined user community



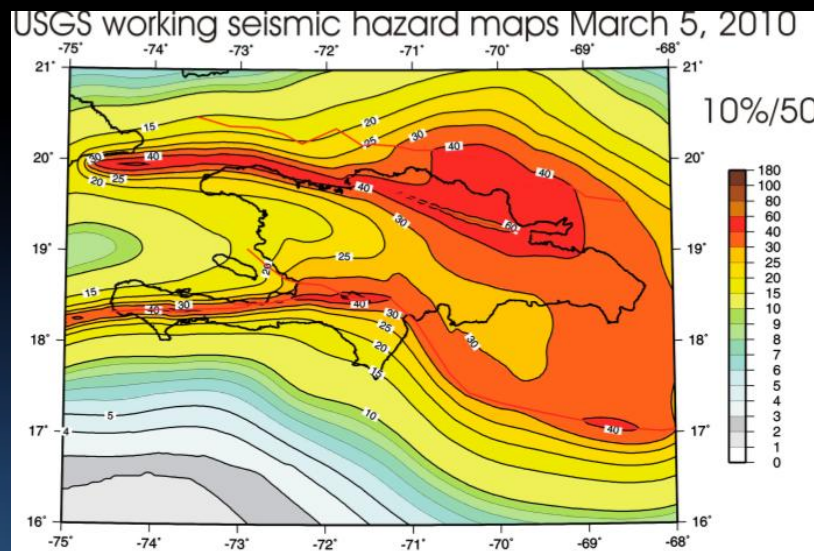
USGS/USAID Earthquake Disaster Assistance Team

- Partnership between USGS and the USAID Office of Foreign Disaster Assistance (OFDA).
- Provides technical assistance, advice and capacity-building in earthquake-prone developing nations.
- Recent post-quake deployments include Indonesia, Malawi, and ongoing in Haiti.



EDAT deployment in Haiti

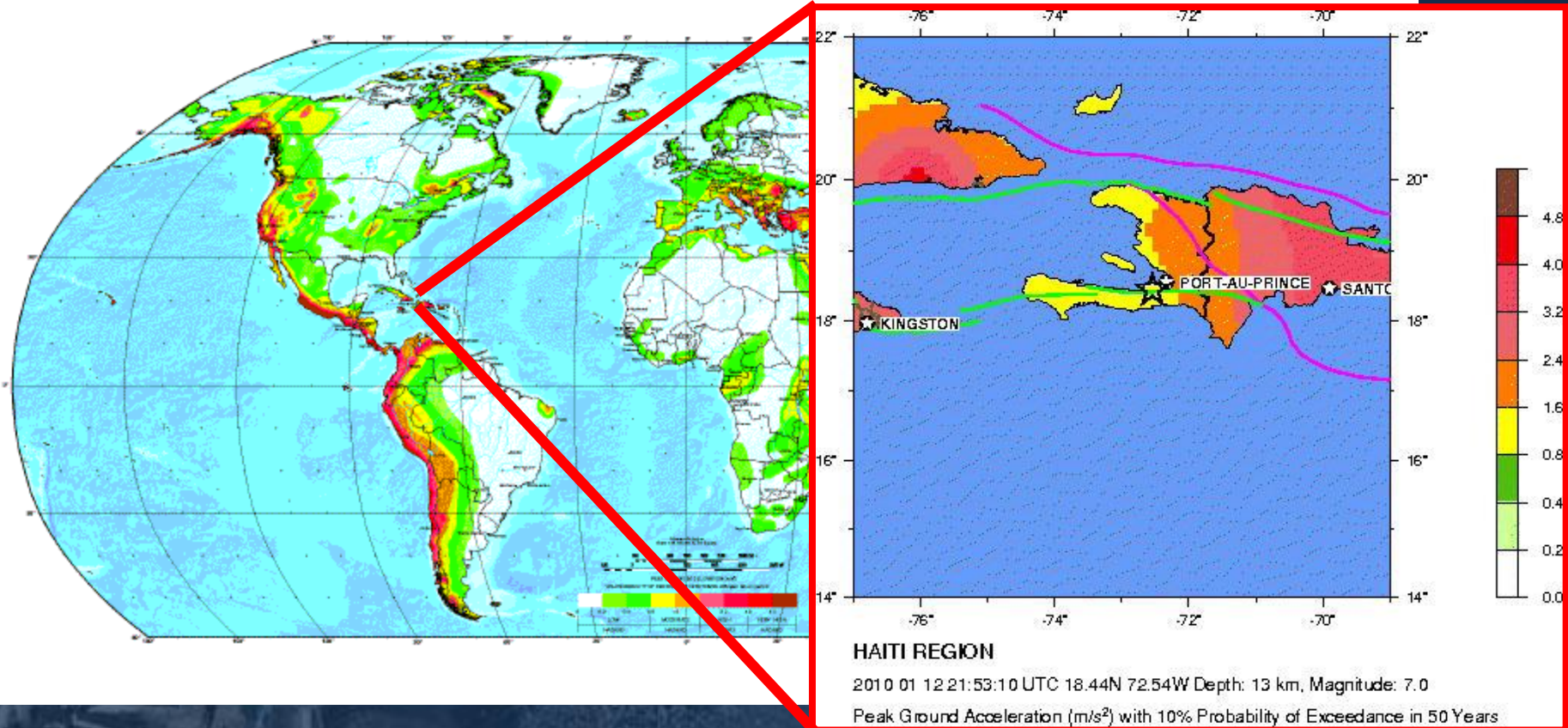
- Temporary seismic station networks established
 - Port au Prince Urban Seismic Network for site-response analysis
 - Near-fault stations for aftershock detection
- Modern seismic hazard assessment for rebuilding
- Investigations of fault rupture and landslides
- Training



USGS and Haitian colleagues from Bureau of Mines and Energy installing station at school (Photo from Sue Hough, USGS)

GSHAP: The current state of global seismic hazard assessment (same as it was in 1999)

Global Seismic Hazard Assessment Project



PUBLIC PARTICIPANTS



GEM

GEW

Have formally adhered already (with financial contribution):



GERMANY



ITALY



SINGAPORE



NORWAY



SWITZERLAND



BELGIUM

Will hopefully adhere soon:



USA



TURKEY



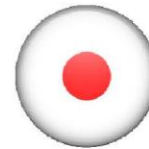
INDIA



CHINA



FRANCE



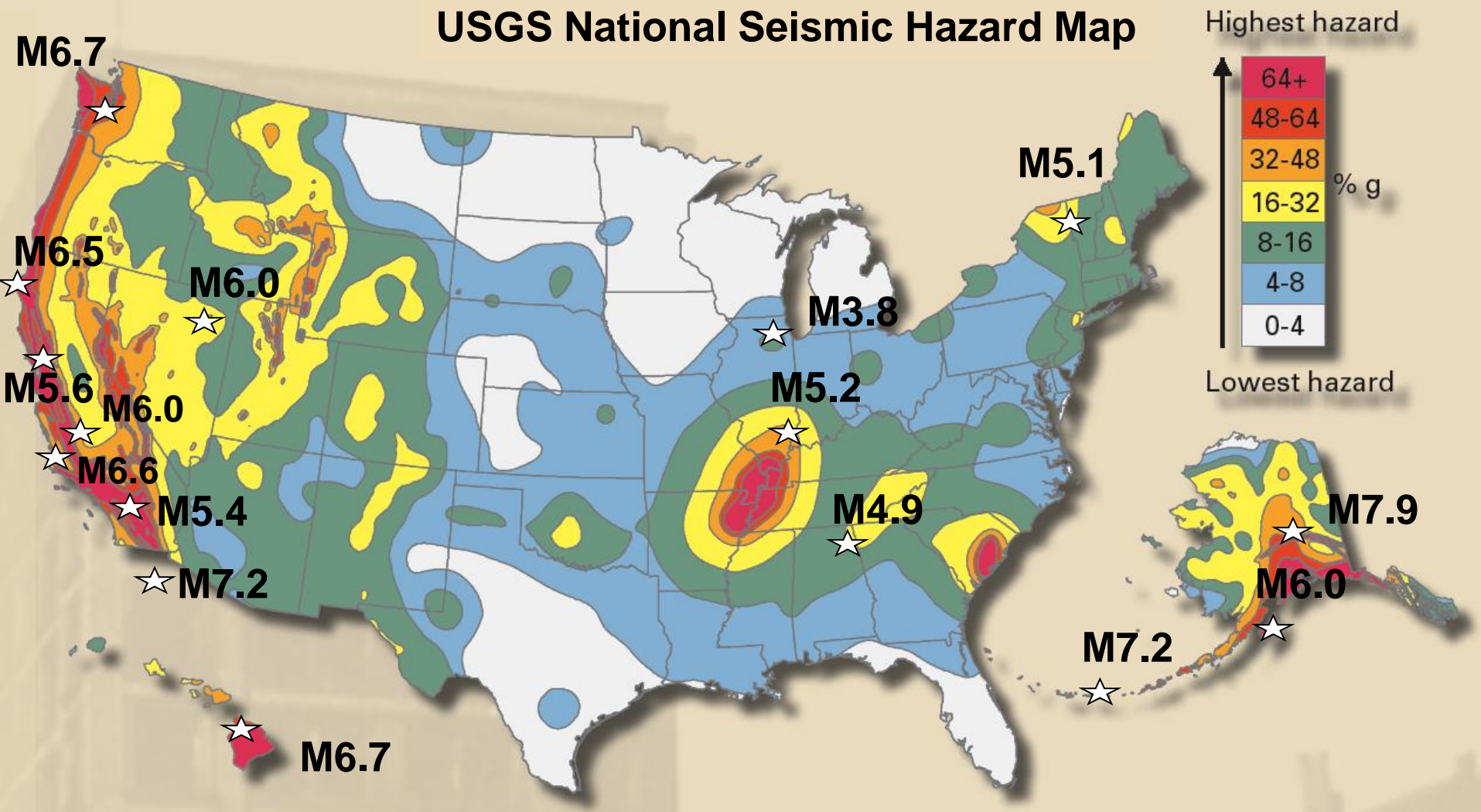
JAPAN

And then many others...

Russia, Australia, New Zealand, Nepal, Bangladesh, Portugal, Luxembourg, ..

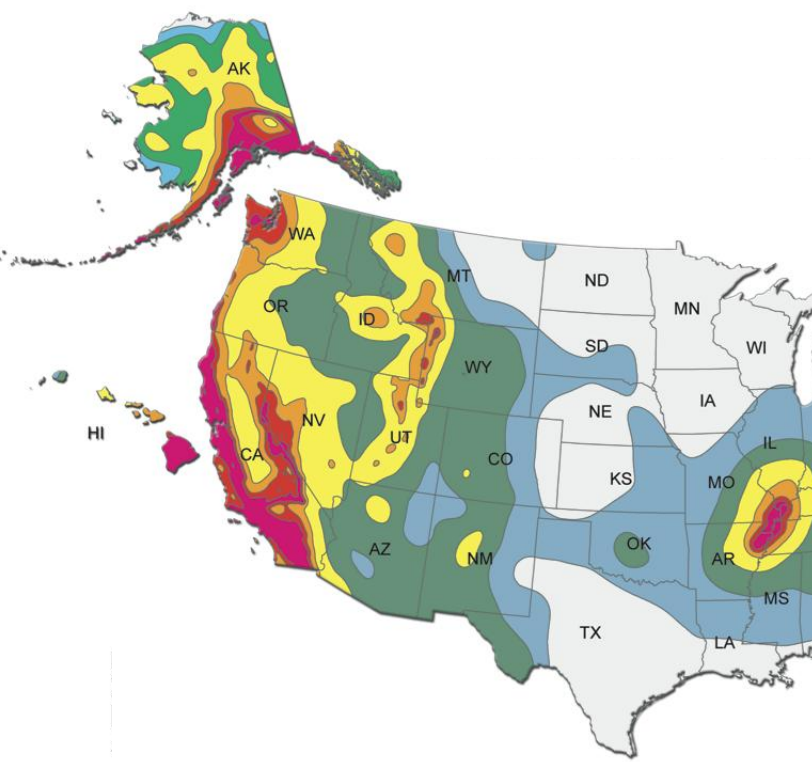
From presentation by Rui Pinho, GEM Secretariat

Earthquakes are a national hazard



★ Notable earthquakes in past decade

Translating USGS national hazard maps into model building codes



NEHRP Recommended Seismic Provisions

for New Buildings and Other Structures

FEMA P-750 / 2009 Edition



FEMA



Seismic element of NEHRP Provisions and Int'l Building Code based on the USGS national seismic hazard map

Putting Down Roots in Earthquake Country

Echando raíces en
tierra de terremotos



Putting Down Roots in Earthquake Country Your Handbook for the San Francisco Bay Region

General Information Product 15

Developed by:

American Red Cross,
Bay Area Chapter
Association of Bay Area
Governments
California Earthquake Authority
California Geological Survey
Earthquake Engineering
Research Institute
Governor's Office of
Emergency Services
San Francisco Office of
Emergency Services and
Homeland Security
Southern California
Earthquake Center
Structural Engineers
Association of Northern California
University of California Berkeley
U.S. Department of Homeland
Security, Federal Emergency
Management Agency
U.S. Geological Survey

U.S. Department of the Interior
U.S. Geological Survey

Sur de California Edición Primavera 2006

Desarrollado por:



<http://pubs.usgs.gov/gip/119/>

Putting Down Roots in Earthquake Country Your Handbook for Earthquakes in Utah

Introduction

The Central United States Is "Earthquake Country"

This handbook provides information about the threat posed by earthquakes in the Central United States, particularly along the New Madrid seismic zone, and explains how you can prepare for, survive, and recover from these inevitable events. If you live or work in the Central United States, you need to know why you should be concerned about earthquakes, what you can expect during and after an earthquake, and what you need to do beforehand to be safe and protect your property.

Much has been learned about the earthquake threat and vulnerability in the Central United States—

We know earthquakes occur here.

The Central United States is not on a plate boundary where most of the world's earthquakes occur, but moderate to light earthquakes are not infrequent in the region. More importantly, large, damaging earthquakes have occurred here in the past and are expected to occur again in the future.

We know where earthquakes are likely to occur and what they can do.

Large, damaging earthquakes in the Central United States are most likely to occur in the New Madrid and Wabash Valley seismic zones. These areas encompass eight states and several large cities in the Nation's heartland and are characterized by several hundred smaller earthquakes every year. Moderate to large earthquakes (generally magnitude 6 and greater), although rare, can kill and injure many people and cause substantial damage to buildings, roads, bridges, and utilities.

We know how to reduce losses in future large earthquakes.

Most casualties and economic losses result from damage to poorly maintained older buildings and their unrestrained contents. Improved building codes can be enforced, older buildings can be strengthened, and steps can be taken to upgrade schools and other critical facilities. Although some Central U.S. residents have taken steps to prepare for earthquakes—such as securing their homes to better withstand shaking, creating emergency plans and disaster supply kits, and holding home earthquake drills—most have not.

Putting Down Roots for the Central US



BUT...

The Great Central U.S. ShakeOut™



Welcome to the Great Central U.S. ShakeOut!

OTHER SHAKEOUTS

SEARCH:

GO

Be a Part of the ShakeOut
Register Now!
[Log in](#)

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News and Events

Media Center

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GET READY TO SHAKEOUT!

[Register](#) now for the 2011 ShakeOut on April 28 at 10:15 a.m.!

[Participate](#) in the Great Central U.S. ShakeOut to practice [how to protect yourself](#) during earthquakes, and to get prepared.

Learn [how](#) to participate below.

**Indiana will ShakeOut on April 19. Also, you can hold your drill at another time or day if best for your schedule.*



Time to 2011 ShakeOut:
3 months, 7 days 21:35:48



ANNOUNCEMENTS

[The Great Central U.S. ShakeOut is a linked event to NLE 2011](#)

[Who is Participating?](#)

[ShakeOut Resources:](#) ShakeOut Drill Manuals, flyers, movies, and much more

[Why Drop, Cover, and Hold On?](#)



QUICK LINKS

How to plan your drill and get prepared:

Select your category...

Earthquake hazards in your state:

Select your state...

[FAQ: Frequently Asked Questions](#)



INTERACTIVE MAP

Over 2.4 million

Participants and Counting!

Click the map for details about each state



Other Areas



LEARN & PLAY

PLAY BEAT THE QUAKE



QUAKE QUIZ

ARE YOU READY?

PREPARE



PROTECT



RECOVER



FEMA



Prepare. Plan. Stay Informed.®



Any questions?

applegate@usgs.gov
703-648-6714

earthquake.usgs.gov

